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Operation

HARDTACK

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Project 6.14

PROOF TEST OF AN/TVS-1 (XE-3) FLASH-RANGING EQUIPMENT

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WT-1661

OPERATION HARDTACK—PROJECT 6.14

PROOF TEST OF AN/TVS-1 (XE-3) FLASH-RANGING EQUIPMENT

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ABSTRACT

The overall objective of this project was to evaluate the Peerless flash-ranging set, AN/TVS-1 (XE-3), prior to its acceptance by the United States Army Signal Research and Development Laboratory (ASRDL).

The specific objectives were to determine the operational capability of two types of automatic shutter-activating units and to compile data on shutter speeds and filter values at different ranges from point of burst of various low-yield nuclear devices.

The project participated in eight detonations at the Nevada Test Site (NTS). Consistent, reliable operation of the equipment tested was obtained at 18 miles from burst. This distance was the maximum line-of-sight range that was available for a suitable observation point.

Although both types of automatic shutter-activating units performed equally well under conditions of high visibility such as existed during the test participations, the modified version was considered most applicable. Camera settings were kept constant, but neutral-density filters of varied transmission factors were experimentally employed.

No recommendation for an overall optimum filtering can be made, because samples included only low-yield detonations and cannot be correlated to higher yields, varying ranges, and changing ambient light conditions.

FOREWORD

This report presents the final results of one of the projects participating in the military-effect programs of Operation Hardtack. Overall information about this and the other military-effect projects can be obtained from ITR–1660, the "Summary Report of the Commander, Task Unit 3." This technical summary includes: (1) tables listing each detonation with its yield, type, environment, meteorological conditions, etc.; (2) maps showing shot locations; (3) discussions of results by programs; (4) summaries of objectives, procedures, results, etc., for all projects; and (5) a listing of project reports for the military-effect programs.

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PROOF TEST OF AN/TVS-1 (XE-3) FLASH-RANGING EQUIPMENT

INTRODUCTION

Objectives. The overall objective of this project was to evaluate the Peerless flash-ranging set, AN/TVS-1 (XE-3), prior to its acceptance by the United States Army Signal Research and Development Laboratory (ASRDL).

The specific objectives were to determine the operational capability of two types of automatic shutter-activating units and to compile data on shutter speeds and filter values at different ranges from point of burst of various low-yield nuclear devices.

Background. A Continental Army Command (CONARC) requirement in 1944 that called for a camera capable of locating enemy artillery and rocket firings was abandoned in 1949 because of the technical inadequacy of wet-film-developing processes. Additional studies made in 1950 resulted in a flash recorder utilizing the Polaroid-Land photographic process. Two prototype models were completed and evaluated by the United States Army Artillery Board. Further design recommendations were incorporated into later developments by ASRDL.

In 1953, an additional CONARC requirement called for the capability of determining the location and height of burst of nuclear weapons delivered by friendly forces. An electronic shutter-actuator (Blue Box Mark IV) was procured from Edgerton, Germeshausen and Grier (EG&G). During Operation Upshot-Knothole, ASRDL and CONARC jointly evaluated a system employing this type of shutter actuator; these tests proved the feasibility of the device (Reference 1). The camera unit utilized a pinhole optical system.

During Operation Teapot (Desert Rock V and VI) a version of the AN/TVS-1 flash-ranging set using glass optics was employed tactically by Battery C, 532d Field Artillery Observation Battalion (Reference 2).

The bulk and weight of the actuator led to the design and development of a compact, lightweight, transistorized unit by ASRDL. This device was employed with earlier models of AN/TVS flash-ranging sets by Project 50.8 during Operation Plumbbob (Reference 3).

In the summer of 1955, a contract was let to Peerless Instrument Company for ten service-test models of the AN/TVS-1 (XE-3) flash-ranging set with automatic shutter-actuating devices. Peerless attempted to employ vacuum tubes in their first variation of the automatic shutter actuator, but the tubes had an extremely short life and consumed large amounts of power.

Test results of the transistorized, automatic actuator developed by ASRDL indicated that this lightweight and compact unit should be incorporated into the camera being fabricated by Peerless.

Delivery of the first four completed models of the Peerless AN/TVS-1 (XE-3) was made to ASRDL in September 1958 for engineer-acceptance tests.

Theory. By using a known baseline and predetermined orientation points, it is possible to detect targets, such as nuclear flashes, by triangulation survey techniques. For accurate data reduction, it is necessary to read to the center of the target's filmed image. The latter should be small—about $\frac{1}{16}$ to $\frac{1}{8}$ inch is considered ideal. To achieve a circumscribed impression of this size, the fireball must be photographed as near to time zero as possible, with filtered lenses. The shutter-actuating system, therefore, must be automatically started with the initial time rise of the nuclear flash.

In order to reduce evenly the amount of light for all wavelengths of the visible spectra that entered the optical system, neutral-density (ND) filters were used. Table 1 describes these filters.

PROCEDURE

Instrumentation. The AN/TVS-1 flash-ranging set is a tripod-mounted, battery-operated, transportable, photographic-recording device (Figures 1 and 2). Immediately in front of the film plane and at right angles to the optical axis is a lined, compensated grid that is superimposed on the film when a picture is exposed through it.

The automatic shutter actuator is a photocell and amplifier combination responding to a fast-time-rise pulse of light that is converted to a usable electrical pulse operating the shutter-tripping mechanism. Two types were used: one (unmodified) in which the electrical pulse output corresponded to the light input pulse in duration, and the other (modified) which had a definite-length output pulse of about 50 msec, regardless of the duration of the light input pulse. Both of these units employed S4 response photocells and time constants that would accept only 50 μsec or faster, rise-time light pulses.

Operations. Tests were conducted from ranges of 2 to 18 miles from ground zero for fractional-kiloton-yield detonations and from 7 to 60 miles for the larger-yield bursts. For a given shot, specific locations on hilltop sites with line of sight to ground zero were determined by results obtained on a previous participation. Table 2 lists the shot participation.

RESULTS

Data were obtained on the operational ranges of the shutter-activating device and on camera settings compatible with a selected ND filter for best image definition. Camera settings of f:32 at $^1/_{200}$ second were used exclusively, a combination that provided the smallest diaphragm opening and fastest shutter speed possible with this camera. Table 3 is a summary of the results attained.

The photographs were analyzed and the data of Table 3 were related to fireball size for a determination of operational ranges for the shutter-activating device and best combinations of filter and camera settings.

DISCUSSION

The flash-ranging equipment functioned properly for all ranges up to 29,000 meters, except during Shot Hamilton, the yield of which was much lower than predicted. At the greater distances, up to 97,000 meters, performance was satisfactory on only one of five occasions. The failures, i.e., nonoperation of the automatic actuators, were attributed to low battery voltages caused by the cold weather that persisted at the selected observation stations. A poor photograph resulted from the first attempt at the longer range, which made clear the need for using a neutral-density filter.

During the first test of the closer (3,600 to 29,000 meters) operations, it was noted that an ND-4 filter proved to be optimum. Subsequent participations at these ranges produced good photographic results. It is considered that these results are valid for the lower yields but are no indication of a capability during larger yield bursts. Previous testing on larger yield weapons as outlined in Reference 3 cannot be correlated with results obtained during this test. It was also noted that the two types of shutter actuators performed equally well. Further evaluation by ASRDL resulted in the conclusion that the modified-type shutter actuator is more reliable than the actuator furnished by the Peerless Instrument Company.

An attempt was made to correlate yield from cloud photography obtained by the AN/TVS cameras used on this series of tests. These results are totally inconclusive and should not be considered because of the limited samples obtained. Graphs in Reference 4 relating yield to cloud measurements were used. Limited picture samples did indicate that cloud stabilization was not uniform and there appeared to be considerable effects from meteorological conditions.

Many minor mechanical deficiencies were found to be present in the equipment during testing. These deficiencies are considered to be correctable and will be enumerated in "Service Test Report" of the United States Army Artillery Board.

CONCLUSIONS AND RECOMMENDATIONS

Under conditions of high visibility such as existed during these test participations, no apparent difference existed in the operation of the shutter actuators. The modified shutter is considered to be more reliable and should be adopted for use on the AN/TVS flash-ranging set.

The camera settings and filters used were satisfactory at the ranges and for the yields involved. Additional testing is required to obtain information on filters, shutter speeds, and lens openings required for larger yield detonations.

REFERENCES

1. R. V. Tiede, D. F. Kelly, and K. C. Burger; "Determination of Height of Burst and Ground Zero"; Project 6.12, Operation Upshot-Knothole, WT–760, May 1955; Army Field Forces Board No. 1, Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey; Secret Restricted Data.

2. "The Location of Atom Bursts by a Field Artillery Observation Battery"; Chapter IV, Report, June 1955; The Artillery and Guided Missile School, Fort Sill, Oklahoma.

3. "Detection of Atomic Burst and Radioactive Fallout"; Project 50.8, Operation Plumbbob, CONARC-56T1, 13 December 1957; Continental Army Command, Fort Monroe, Virginia; Secret Restricted Data.

4. "Capabilities of Atomic Weapons"; Department of the Army Technical Manual, TM 23-200; Department of the Navy, OPNAV Instruction 03400.1B; Department of the Air Force, AFL 136-1; Marine Corps Publications, NAVMC 1104 Rev; Revised Edition November 1957; Headquarters Armed Forces Special Weapons Project, Washington, D. C.; Confidential.

TABLE 1 NEUTRAL-DENSITY FILTERS, WRATTEN NO. 96

Filter	Percent Transmission
1	10
2	1.0
3	0.1
4	0.01

TABLE 2 SUMMARY OF SHOT PARTICIPATION

Shot	Preliminary Yield	Platform	Area	Time	Date
					1958
Mora	1.9 kt	1,500-ft balloon	7b	0605	29 Sep
Quay	90 tons	100-ft tower	7c	0630	10 Oct
Lea	1.5 kt	1,500-ft balloon	7b	0520	13 Oct
Hamilton	1.17 tons	50-ft tower	FF	0800	15 Oct
Dona Ana	38 tons	500-ft balloon	7b	0620	16 Oct
Rio Arriba	92 tons	70-ft tower	3	0625	18 Oct
Wrangell	115 tons	1,500-ft balloon	FF	0850	22 Oct
Socorro	6.3 kt	1,500-ft balloon	7b	0530	22 Oct

TABLE 3 SUMMARY OF RESULTS

Shot	Observation Post Location	Slant Range	Camera Serial Number	ND Filter	Automatic Actuator Type *	Actuator Operated	Image Definition
		meters					
Observation Post No. 1:							
Mora	736/790	29,000	2	2	M	Yes	Poor
Quay	736/790	29,000	2,5	3,4	UM, M	Yes and No	Good
Lea	736/790	29,000	2	4	UM	Yes	Good
Hamilton	736/790	22,000	2,5	3	UM, M	No	None
Dona Ana	736/790	29,000	2,5	3,4	UM, M	Yes	Good
Rio Arriba	736/033	11,000	2,8,5	4	UM, M	Yes	Good
Wrangell	736/790	22,000	2	4	M	Yes	Good
Socorro	736/790	29,000	2	4	M	Yes	Good
Observation Post No. 2:							
Mora	854/875	17,000	8	3	UM	Yes	Good
Quay	854/875	17,000	8	4	UM	Yes	Poor
Lea	854/875	17,000	8	4	M	Yes	Good
Hamilton	837/830	15,000	8	4	M	No	None
Dona Ana	854/875	17,000	8	3	M	Yes	Good
Rio Arriba	843/024	3,600	3	4	UM	Yes	Good
Observation Post No. 3:							
Mora	790/940	12,800	3	4	UM	Yes	Good
Quay	843/946	7,500	3	4	UM	Yes	Good
Lea	790/940	12,800	3	4	UM	Yes	Good
Hamilton	880/713	7,000	3	4	UM	No	None
Dona Ana	843/946	7,500	3	4	UM	Yes	Good
Socorro	790/940	12,800	3	4	UM	Yes	Good
Observation Post No. 4:							
Lea	204/175	97,000	5	None	M	Yes	Poor
Wrangell	204/175	77,000	8,5	1,2	UM, M	No	None
Socorro	204/175	97,000	8,5	1,2	UM, M	No	None

* M, modified actuator; UM, unmodified actuator.

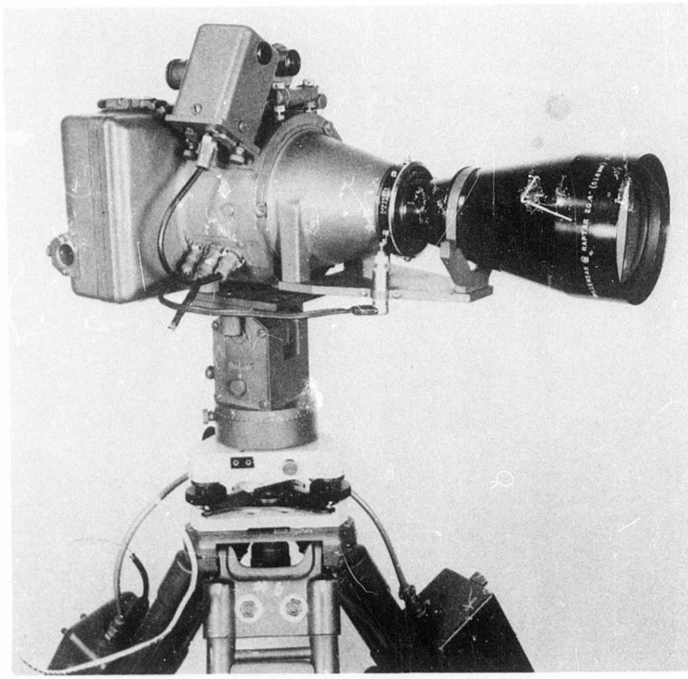

Figure 1 Peerless flash-ranging set, AN/TVS-1 (XE-3), showing camera with 20-inch lens, automatic actuator, camera mount, leveler, tripod, control box, and battery box.

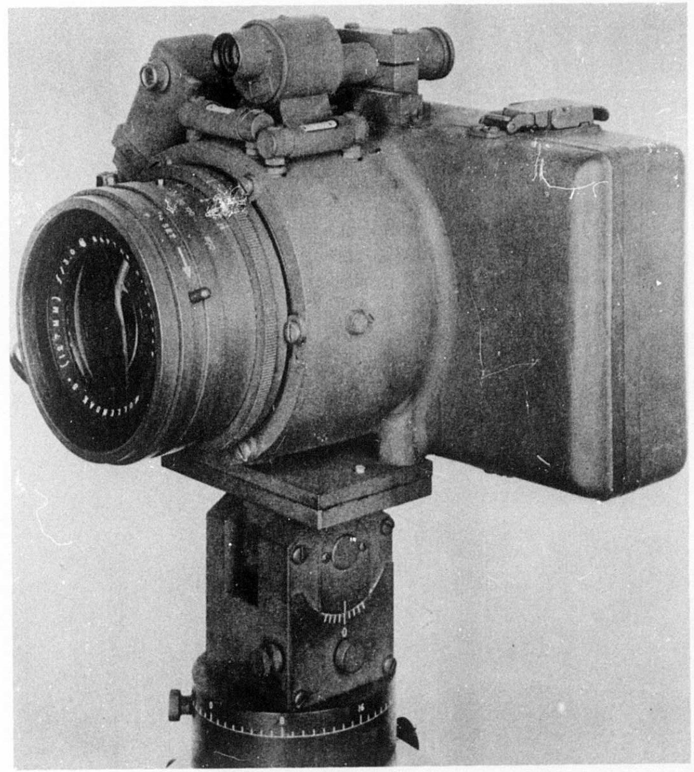

Figure 2 Peerless flash-ranging set, AN/TVS-1 (XE-3), showing camera with 5-inch lens.

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